Preliminary Laboratory Treatability Studies for Landfill Leachate PFAS Treatment

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Agenda for Today

What are Treatability Studies?

Remediation Challenges

Preliminary Treatability Studies

What are Treatability Studies?

Treatability Study

What is a Treatability Study?

- Bench scale testing performed in a laboratory
- Uses site soil/sediment/rock/ and/or groundwater
- “Microcosms” use site materials to demonstrate site processes on a small scale
- Optimized conditions
- Can manipulate conditions to test a variety of treatment scenarios

When is a Treatability Study Recommended?

- When “proof of concept” is required by client/regulator/stakeholder
- For most in situ treatments since site specific conditions have a significant effect on treatment parameters
- For large treatments where a small decrease in dose will produce large cost savings
- For changes to industrial processes where significant equipment modifications will be made

GHD ITG Group:

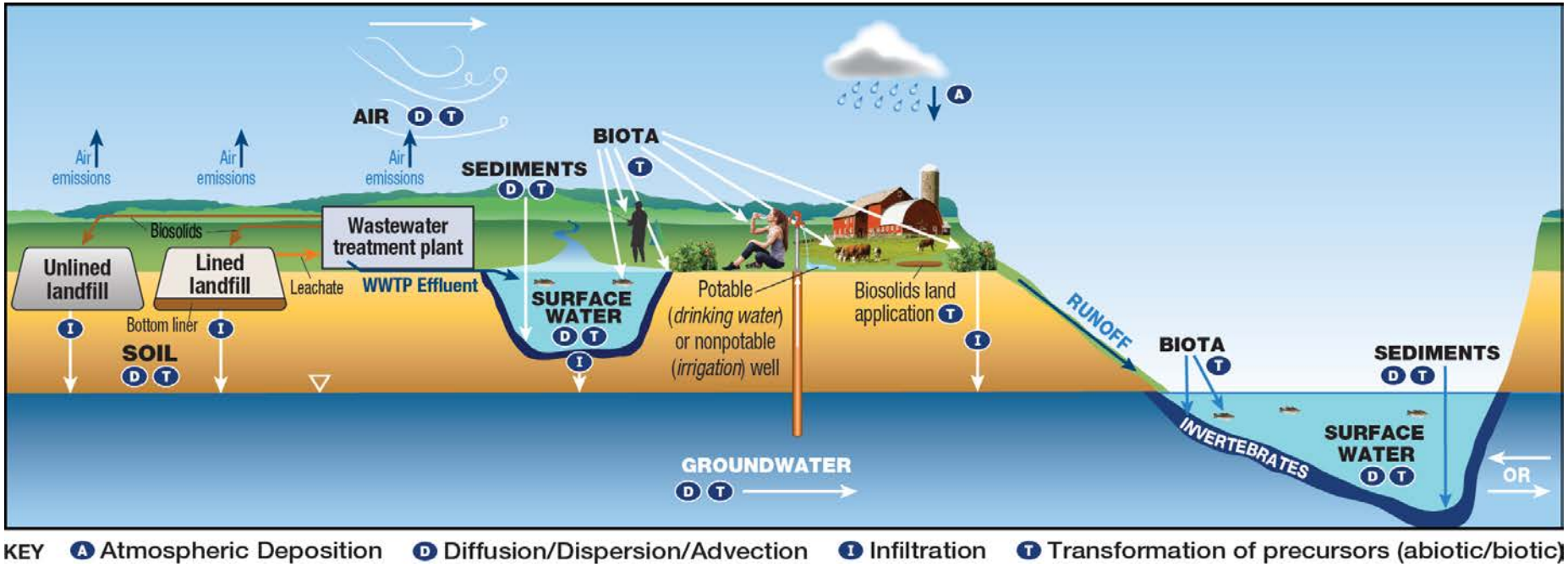
The GHD Innovative Technology Group is a dedicated team of scientists and engineers that maintains a fully equipped treatability laboratory facility in Niagara Falls, NY

GHD ITG Group:

- ITG Services
  - Innovative Remedial Technology Assessment and Conceptual Design/Cost
  - Design and implementation of lab scale treatment models for complex systems
  - Laboratory treatability studies for in situ and ex situ applications
  - Analytical and molecular biology lab services
  - Fast turn, problem solving, trouble shooting
  - Pilot scale / full scale design
  - Forensic analysis/interpretation of forensic data

Remediation Challenges

Conceptual Site Model for Landfills



Source: ITRC Fate and Transport Fact Sheet March 2018

- Landfills are sources of PFAS due to being ultimate repositories for PFAS contaminated industrial waste, sewage sludge, waste from site mitigation, and consumer goods

- Effective PFAS treatment options are necessary to deal with multiple exposure pathways

Treatment options | Water

Field Demonstrated	Emerging – Pilot / Bench Scale
• Granular Activated Carbon (GAC) • Ion Exchange • Nanofiltration • Reverse Osmosis • Ozone fractionation	• Coagulation • Electrochemical • Advanced Oxidation/Reduction • Sonochemical • Plasma • Biodegradation

Treatment options | Soil / infrastructure

Excavation and incineration

- High temperatures and off gas treatment required to destroy PFAS
- Requires high temperature incinerators

On-site stabilization

- e.g., stabilization with products such as Rembind or Activated Carbon
- Does not destroy PFAS

On-site containment

- On-site landfill construction
- Does not destroy PFAS

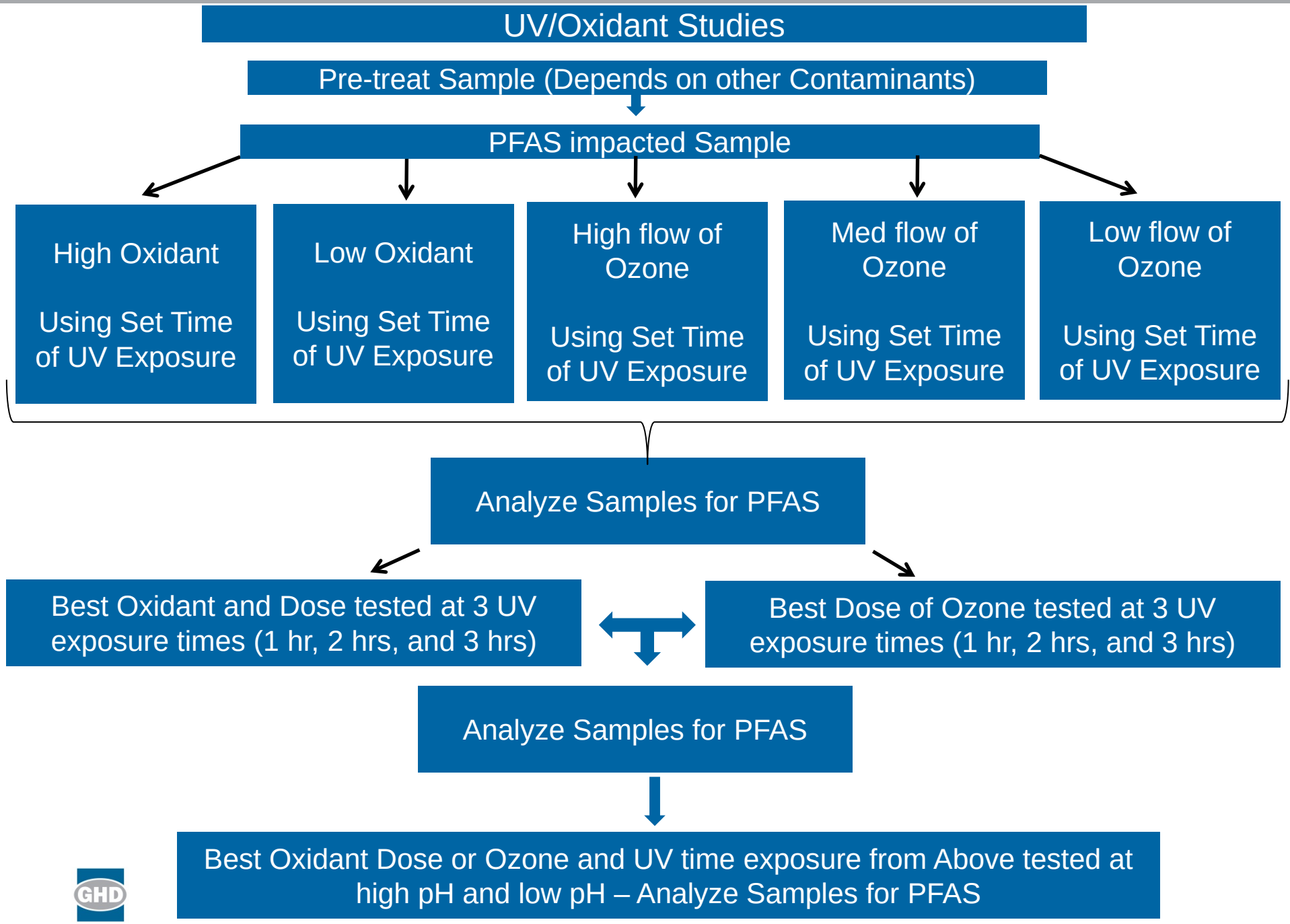
Preliminary Treatability Studies

Who are our partners?

XDD, reputable remedial technology company with a treatability lab in NH

Test America, US national commercial laboratory that we have partnered with for decades. They are currently doing 1,000s of PFAS analyses/week and are recognized PFAS analytical experts

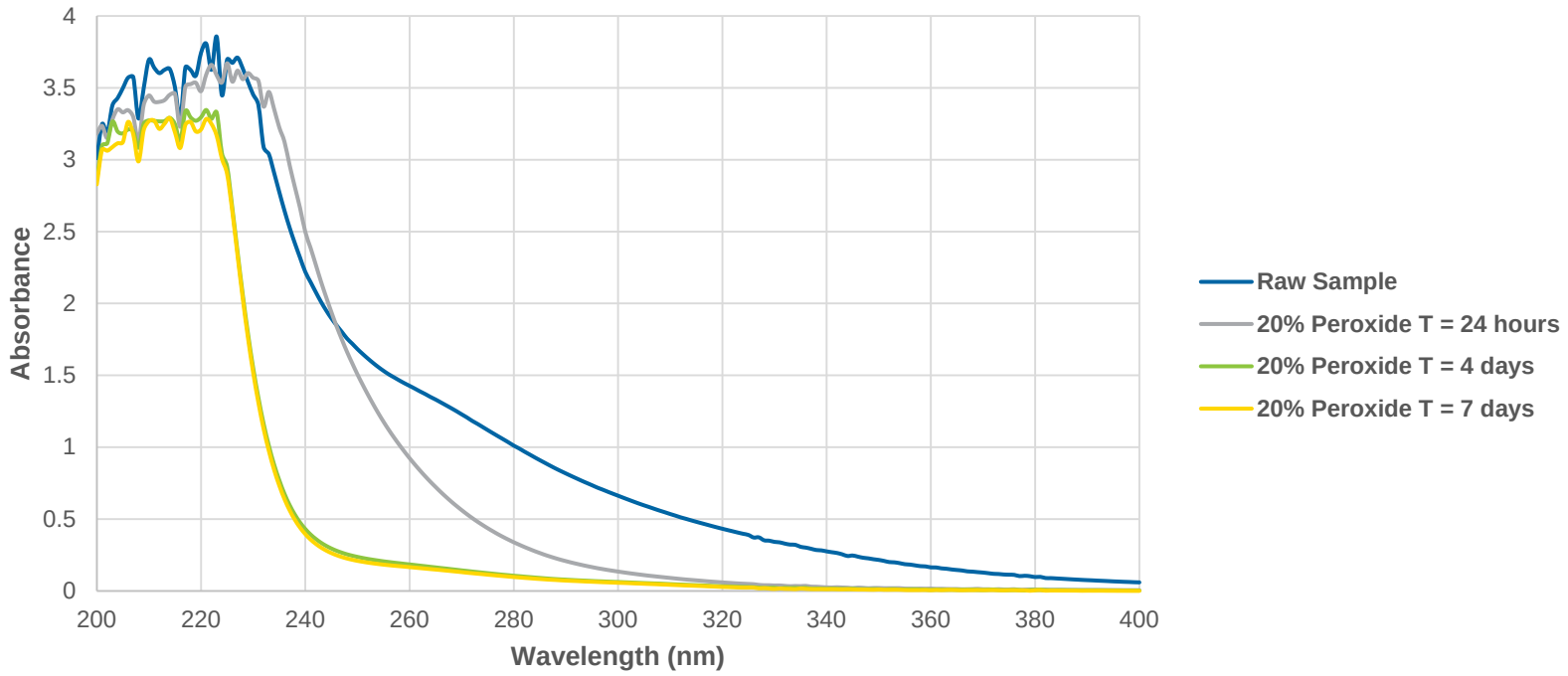
Alpha Analytical, NE regional, reputable laboratory already doing PFAS studies


UV/Oxidant Studies
Pre-treat Sample (Depends on other Contaminants)
PFAS impacted Sample
High Oxidant
Using Set Time of UV Exposure
Low Oxidant
Using Set Time of UV Exposure
High flow of Ozone
Using Set Time of UV Exposure
Med flow of Ozone
Using Set Time of UV Exposure
Low flow of Ozone
Using Set Time of UV Exposure
Analyze Samples for PFAS
Best Oxidant and Dose tested at 3 UV exposure times (1 hr, 2 hrs, and 3 hrs)
Best Dose of Ozone tested at 3 UV exposure times (1 hr, 2 hrs, and 3 hrs)
Analyze Samples for PFAS
Best Oxidant Dose or Ozone and UV time exposure from Above tested at high pH and low pH – Analyze Samples for PFAS

Initial landfill leachate PFAS results

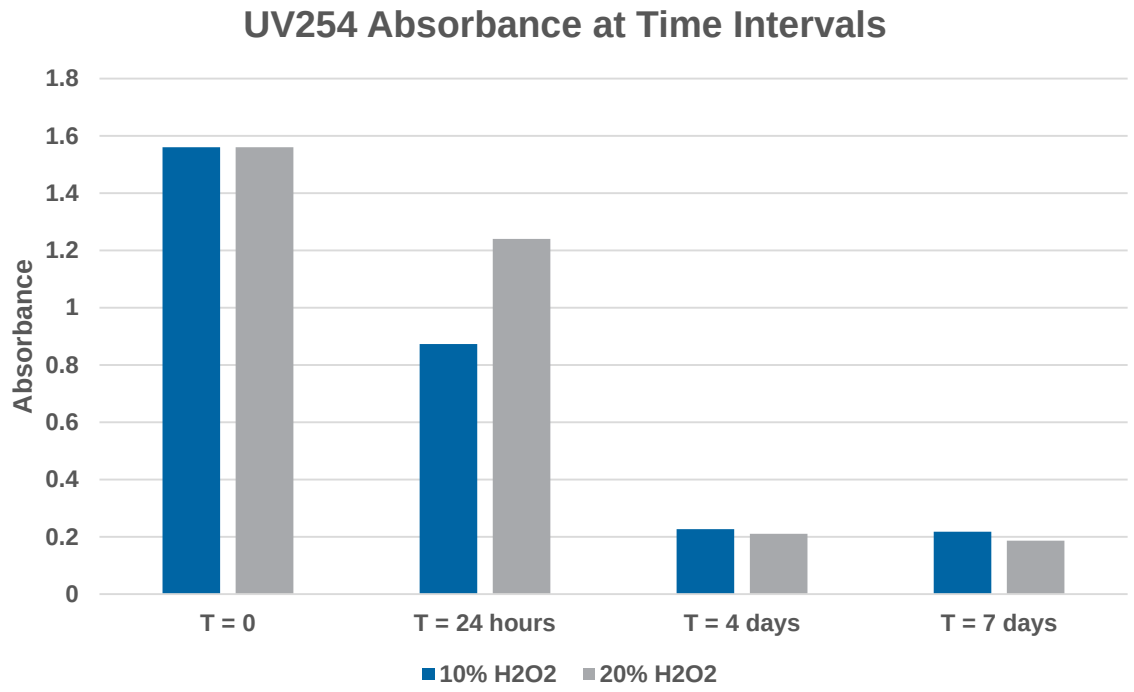
		Municipal	Municipal	Industrial
8:2-FTS (8:2 Fluorotelomer Sulfonic Acid)	ng/L	32	110	ND (4.6)
NEtFOSAA	ng/L	68	310	ND (2.3)
NMeFOSAA	ng/L	57	110	ND (2.3)
PFBS (Perfluorobutanesulfonic Acid)	ng/L	6300	6900	130
PFHpS (Perfluoroheptanesulfonic Acid)	ng/L	ND (4)	ND (20)	80
PFHxS (Perfluorohexanesulfonic Acid)	ng/L	440	1200	570
PFOS (Perfluorooctanesulfonic Acid)	ng/L	190	340	5,500
PFPeS (Perfluoropentanesulfonic Acid)	ng/L	ND (4)	ND (20)	270
PFBA (Perfluorobutanoic Acid)	ng/L	2800	530	200
PFDA (Perfluorodecanoic Acid)	ng/L	75	100	ND (2.1)
PFHpA (Perfluoroheptanoic Acid)	ng/L	490	850	30
PFHxA (Perfluorohexanoic Acid)	ng/L	2100	4800	60
PFNA (Perfluorononanoic Acid)	ng/L	110	91	ND (0.92)
PFOA (Perfluorooctanoic Acid)	ng/L	1600	4100	100
PFPeA (Perfluoropentanoic Acid)	ng/L	660	760	ND (4.6)

Pretreatment for UV Advanced Oxidation/Reduction Studies



- Pre-treatment of Landfill Leachate samples is required to test UV AOP/RP
- Calgon suggests UV254 absorbance below 0.07

Pretreatment for UV Advanced Oxidation/Reduction Studies

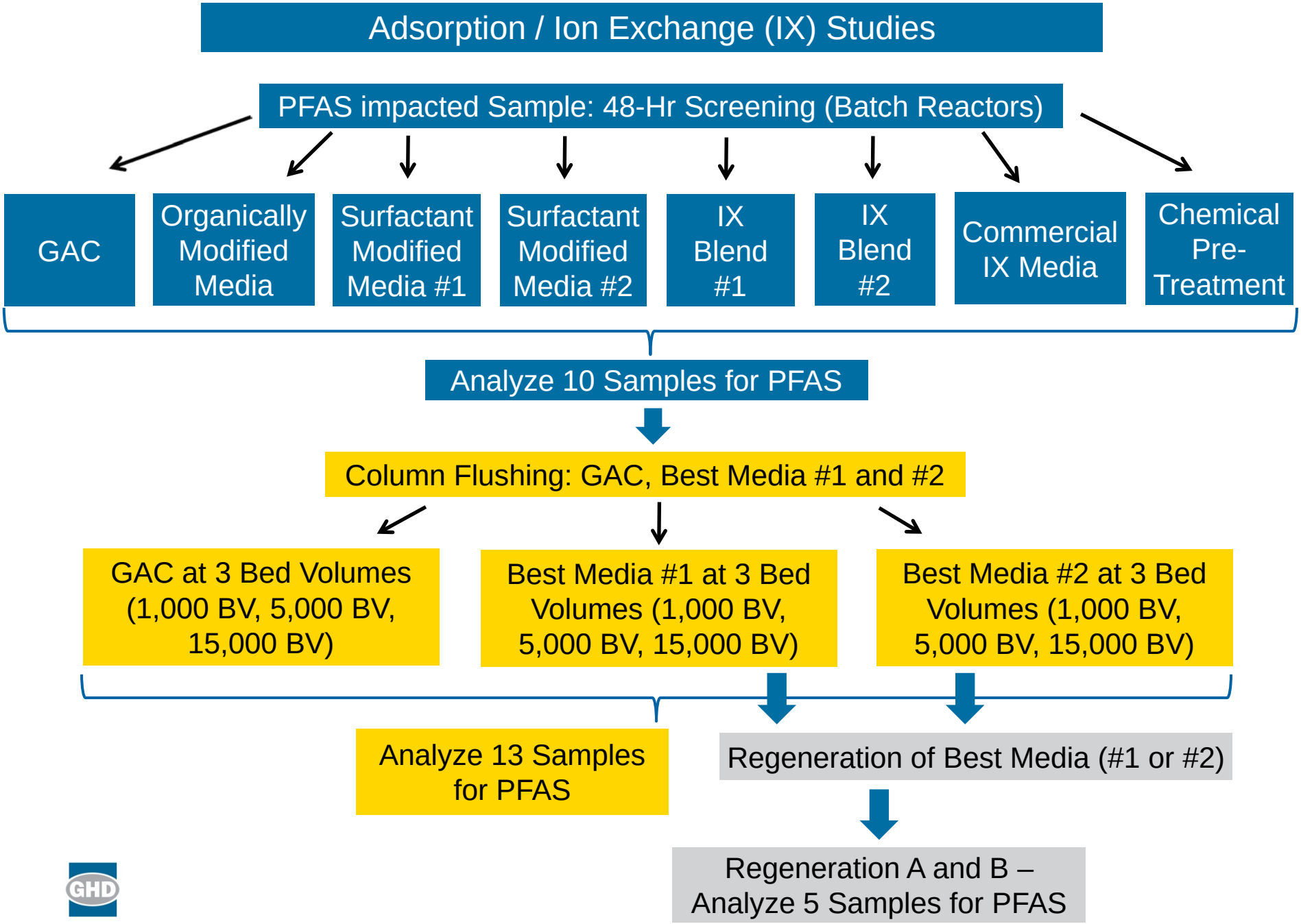


- Fenton's reagent alone significantly reduced UV254 absorbance, but not below 0.07
- PAC is being tested before Fenton's reagent to further reduce absorbance

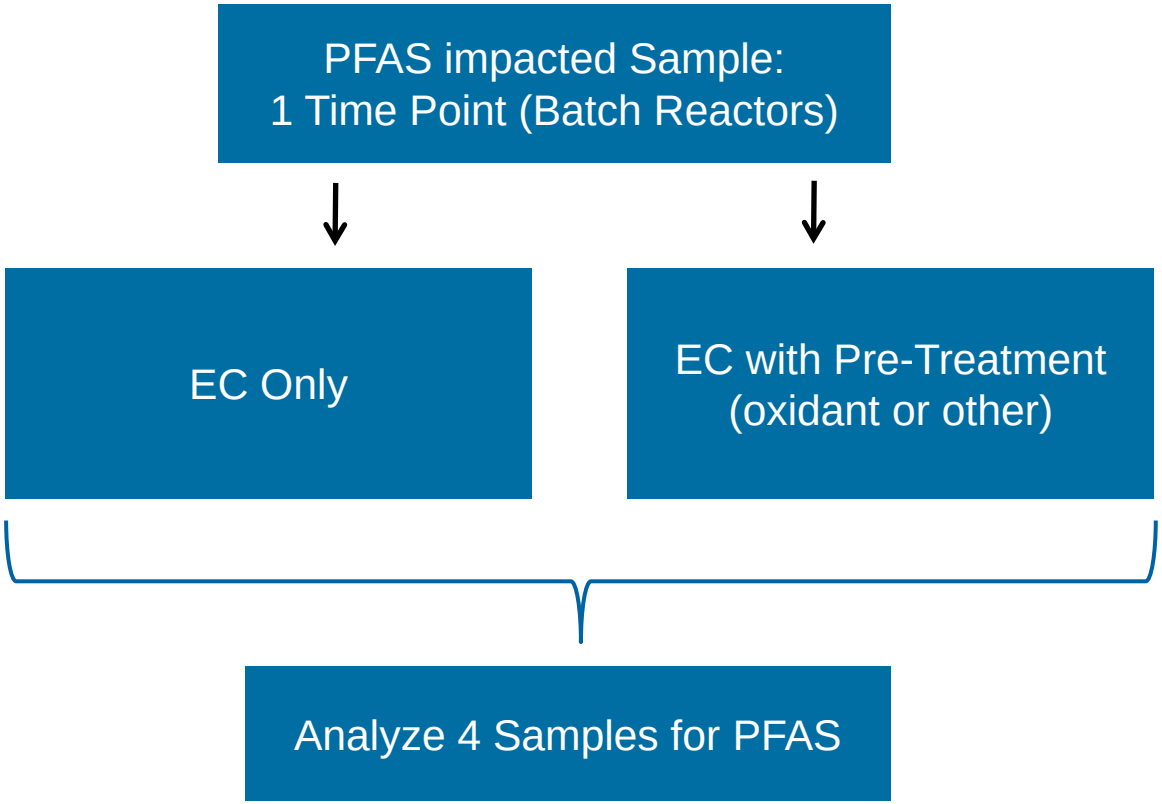
Pretreatment for UV Advanced Oxidation/Reduction Studies

		Initial	Fenton's Reagent	
Parameters	Units	Industrial	Industrial	Net Change from Initial
PFBS (Perfluorobutanesulfonic Acid)	ng/L	130	120	-10
PFDS (Perfluorodecanesulfonic Acid)	ng/L	ND (1.4)	0.5	0.5
PFHpS (Perfluoroheptanesulfonic Acid)	ng/L	80	94	14
PFHxS (Perfluorohexanesulfonic Acid)	ng/L	570	560	-10
PFNS (Perfluorononanesulfonic Acid)	ng/L	3	2.2	-0.8
PFOS (Perfluorooctanesulfonic Acid)	ng/L	5,500	5,600	100
PFPeS (Perfluoropentanesulfonic Acid)	ng/L	270	230	-40
PFBA (Perfluorobutanoic Acid)	ng/L	200	70	-130
PFHpA (Perfluoroheptanoic Acid)	ng/L	30	37	7
PFHxA (Perfluorohexanoic Acid)	ng/L	60	92	32
PFNA (Perfluorononanoic Acid)	ng/L	ND (0.92)	2.4	2.4
PFOA (Perfluorooctanoic Acid)	ng/L	100	86	-14
PFPeA (Perfluoropentanoic Acid)	ng/L	ND (4.6)	47	47

After Fenton's reagent, the largest changes are a decrease in PFBA and increase in PFOS.


Adsorption / Ion Exchange (IX) Studies
PFAS impacted Sample: 48-Hr Screening (Batch Reactors)
GAC
Organically Modified Media
Surfactant Modified Media #1
Surfactant Modified Media #2
IX Blend #1
IX Blend #2
Commercial IX Media
Chemical Pre-Treatment
Analyze 10 Samples for PFAS
Column Flushing: GAC, Best Media #1 and #2
GAC at 3 Bed Volumes (1,000 BV, 5,000 BV, 15,000 BV)
Best Media #1 at 3 Bed Volumes (1,000 BV, 5,000 BV, 15,000 BV)
Best Media #2 at 3 Bed Volumes (1,000 BV, 5,000 BV, 15,000 BV)
Analyze 13 Samples for PFAS
Regeneration of Best Media (#1 or #2)
Regeneration A and B – Analyze 5 Samples for PFAS

Destruction (Electrochemical [EC]) Studies



Additional GHD research

- Testing drinking water and groundwater sources with UV Advanced Oxidant/Reductant technology
- Evaluation of permeability of landfill liners to PFAS migration
- Evaluation of concrete coatings to mitigate PFAS from leaching
- PFAS Soil Washing Approach (with GHD Australia)
- Soil/sediment/waste stabilization to bind PFAS without future leaching
- Partnering with universities as an industrial partner for research grants (eg. US DoD) for forensic evaluations and using machine learning

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XDD ENVIRONMENTAL

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